IN THE CLAIMS

1.   (currently amended) A method for Cause and Effect application logic implementation, said method comprising the steps of:

defining a formal methodology for specification of functional requirements for a target system based upon Cause and Effect notation and function ~~blocks;~~blocks, wherein said defining includes generating a function block applied to control a target system that cannot be controlled by applying the Cause and Effect notation;

employing a computer–aided specification tool–set to support capture and validation of functional requirements; and

employing a software module to directly execute Cause and Effect application logic.

2.   (original) A method according to Claim 1 wherein said step of defining a formal methodology for specification of functional requirements comprises the step of dividing functional requirements into at least two functional areas including at least one of a device control area and a plant control area.

3.   (original) A method according to Claim 1 wherein said step of defining a formal methodology for specification of functional requirements comprises the step of dividing functional requirements into at least two functional areas including a device control area and a plant control area.

4.   (original) A method according to Claim 3 wherein said step of dividing functional requirements comprises the steps of:

defining logic requirements for device control; and

defining logic requirements for plant control.

5.   (original) A method according to Claim 4 wherein said step of defining logic requirements for device control further comprises the step of creating a device control function block that corresponds to at least one field device.

6. (original) A method according to Claim 5 wherein said step of creating a device control function block further comprises creating a device control function block comprising target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system.

7. (original) A method according to Claim 6 wherein said step of creating a device control function block further comprises the step of creating a device control function block including target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system including at least one HMI requirement, at least one operation requirement, and at least one maintenance requirement.

8. (original) A method according to Claim 7 wherein said step of creating a device control function block further comprises the step of creating a device control function block comprising target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system including at least one HMI requirement comprising at least one of a graphical icon representing the device control function block, an operator control pop–up, a maintenance control pop–up, and an alarm priority and data logging information on a function block signal basis.

9. (original) A method according to Claim 5 wherein said step of creating a device control function block further comprises the step of using the same device control function block throughout specification of functional requirements of a safety related application for a target PLC system wherever that type of device is controlled.

10. (original) A method according to Claim 1 wherein said step of defining a formal methodology for specification of functional requirements of a safety related application for a target PLC system based upon Cause and Effect notation and function blocks further comprises the step of creating at least one input conditioning function block to derive, for at least one input, at least one of a consolidated signal and a modified signal.

11.   (original) A method according to Claim 4 wherein said step of defining logic requirements for plant control further comprises the steps of:

using pre–defined Cause and Effect notation; and

creating a Cause and Effect control function block for each plant control logic function that cannot be described using pre–defined Cause and Effect notation, the Cause and Effect control function block comprising defined input requirements, defined output requirements, operation requirements, and maintenance requirements.

12.   (original) A method according to Claim 11 wherein said step of creating a Cause and Effect control function block for each plant control logic function that cannot be described using pre–defined Cause and Effect notation further comprises the step of arranging Cause and Effect control function block output demands on an upper side of the Cause and Effect control function block.

13.   (original) A method according to Claim 7 wherein said step of using pre–defined Cause and Effect notation further comprises the step of using Boolean variables.

14.   (original) A method according to Claim 13 wherein said step of using Boolean variables further comprises the step of using less than eleven Boolean variables.

15.   (original) A method according to Claim 1 wherein said step of employing a computer-aided specification tool-set to support capture and validation of functional requirements further comprises the step of employing application software to develop a database of logic symbols and function blocks that are directly implemented using executive software, the database including Cause and Effect notation, Cause and Effect control function blocks, device control function blocks, user-defined function blocks, and input conditioning function blocks.

16.   (original) A method according to Claim 15 further comprising the step of employing application software to construct a Cause and Effect specification chart.

17.   (original) A method according to Claim 16 further comprising the step of employing application software to apply pre-defined validation rules.

18.   (original) A method according to Claim 17 further comprising the step of employing application software to modify the Cause and Effect specification chart post implementation.

19.   (original) A method according to Claim 18 wherein said step of employing application software to develop a database of logic symbols and function blocks that are directly implemented using executive software further comprises the steps of:

utilizing a Cause and Effect notation; and

utilizing at least one function block with pre-defined executable logic for a target PLC system.

20.   (original) A method according to Claim 19 further comprising the steps of:

providing for automated creation of an HMI database from the function blocks;

providing for automated generation of HMI graphic icons from the function blocks;

providing for creation of additional user-defined function blocks specific to functional requirements of the target PLC system that are not found in the database of function blocks; and

providing for automated generation of input signal tags and output signal tags from the database of logic symbols and function blocks.

21.   (original) A method according to Claim 16 wherein said step of employing application software to construct a Cause and Effect specification chart further comprises the steps of:

utilizing a Cause and Effect chart grid layout comprising at least one column that corresponds to an output signal that intersects at least one row that corresponds to at least one input signal;

defining the dimensions of the Cause and Effect chart grid to correspond to functional requirements of a safety related application for a target PLC system;

selecting input signal tags and output signal tags from each pre–defined function block corresponding to functional requirements of the safety related application for the target PLC system;

placing input and output signal tags on the Cause and Effect chart grid;

selecting Cause and Effect notation and at least one Cause and Effect control function block corresponding to at least one function requirement of the safety related application for the target PLC system; and

placing Cause and Effect notation on the Cause and Effect chart grid at the intersection of input signal tags and output signal tags corresponding to a direct connection of alarm states to shutdown actions for the target PLC system.

22.   (original) A method according to Claim 17 wherein said step of employing application software to apply pre-defined validation rules comprises the steps of:

conforming Cause and Effect notation to a specified structure;

validating function block connections and data types; and,

verifying consistency of defined functional requirements and safety system input/output index.

23.   (original) A method according to Claim 1 wherein said step of employing a software module to directly execute Cause and Effect application logic further comprises the steps of:

customizing a standard function block database to correspond to a target PLC system platform;

re–validating the standard function block database to correspond to the target PLC system platform;

loading an executive software package onto the target PLC system

loading an application software package onto the target PLC system;

loading an executable Cause and Effect chart grid corresponding to function requirements onto the target PLC system; and

utilizing the executive software to solve all base Cause and Effect logic gate input requirements.

24.   (currently amended) A computer for Cause and Effect application logic implementation, said computer configured to:

receive a defined formal methodology for specification of functional requirements for a target system based upon Cause and Effect notation and function blocks;blocks, wherein the function blocks are applied to control a target system that cannot be controlled by applying the Cause and Effect notation;

capture at least one functional requirement;

validate at least one captured functional requirement; and

directly execute Cause and Effect application logic.

25.   (original) A computer according to Claim 24, wherein said computer further configured to receive at least one functional requirement pertaining to at least two functional areas including at least one of a device control area and a plant control area.

26.   (original) A computer according to Claim 24 wherein said computer further configured to receive at least one functional requirement pertaining to at least two functional areas including a device control area and a plant control area.

27.   (original) A computer according to Claim 26 wherein said computer further configured to:

receive defined logic requirements for device control; and

receive defined logic requirements for plant control.

28.   (original) A computer according to Claim 27 wherein said computer further configured to generate at least one device control function block that corresponds to at least one field device in a Human Machine Interface (HMI).

29.   (original) A computer according to Claim 28 wherein said computer further configured to generate at least one a device control function block comprising target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system.

30.   (original) A computer according to Claim 29 wherein said computer further configured to generate at least one device control function block comprising target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system including at least one HMI requirement, at least one operation requirement, and at least one maintenance requirement.

31.   (original) A computer according to Claim 30 wherein said computer further configured to generate at least one device control function block comprising target PLC system executable logic in the form of input signal tags representing alarm states and output signal tags representing shutdown actions for a target PLC system including at least one HMI requirement comprising at least one of a graphical icon representing the device control function block, an operator control pop–up, a maintenance control pop-up, and an alarm priority and data logging information on a function block signal basis.

32.   (original) A computer according to Claim 28 wherein said computer further configured to use the same device control function block throughout specification of functional requirements of a safety related application for a target PLC system wherever that type of device needs to be controlled.

33.   (original) A computer according to Claim 24 wherein said computer further configured to receive a defined formal methodology for specification of functional requirements of a safety related application for a target PLC system based upon Cause and Effect notation and function blocks further comprises the step of

creating at least one input conditioning function block to derive, for at least one input, at least one of a consolidated signal and a modified signal.

34.   (original) A computer according to Claim 27 wherein said computer further configured to:

display pre-defined Cause and Effect notation; and

generate at least one Cause and Effect control function block for each plant control logic function that cannot be described using pre-defined Cause and Effect notation, the Cause and Effect control function block comprising defined input requirements, defined output requirements, operation requirements, and maintenance requirements.

35.   (original) A computer according to Claim 34 wherein said computer further configured to generate a Cause and Effect control function block for each plant control logic function that cannot be described using pre-defined Cause and Effect notation further comprises the step of arranging Cause and Effect control function block output demands on an upper side of the Cause and Effect control function block.

36.   (original) A computer according to Claim 30 wherein said computer further configured to display at least one Boolean variable.

37.   (original) A computer according to Claim 36 wherein said computer further configured to use less than eleven Boolean variables.

38.   (original) A computer according to Claim 24 wherein said computer further configured to contain a database of logic symbols and function blocks that are directly implemented using executive software, the database comprising Cause and Effect notation, Cause and Effect control function blocks, device control function blocks, user–defined function blocks, and input conditioning function blocks.

39.   (original) A computer according to Claim 38 wherein said computer further configured to construct a Cause and Effect specification chart.

40.   (original) A computer according to Claim 39 wherein said computer further configured to apply at least one pre–defined validation rule.

41.   (original) A computer according to Claim 40 wherein said computer further configured to modify the Cause and Effect specification chart post implementation.

42.   (original) A computer according to Claim 38 wherein said computer further configured to:

utilize a Cause and Effect notation; and

utilize at least one function block with pre–defined executable logic for a target PLC system.

43.   (original) A computer according to Claim 42 wherein said computer further configured to:

provide for automated creation of an HMI database from the function blocks;

provide for automated generation of HMl graphic icons from the function blocks;

provide for creation of additional user–defined function blocks specific to functional requirements of the target PLC system that are not found in the database of function blocks; and

provide for automated generation of input signal tags and output signal tags from the database of logic symbols and function blocks.

44.   (original) A computer according to Claim 39 wherein said computer further configured to:

utilize a Cause and Effect chart grid layout comprising at least one column that corresponds to an output signal that intersects at least one row that corresponds to at least one input signal;

define at least one dimension of the Cause and Effect chart grid to correspond to functional requirements of a safety related application for a target PLC system;

receive selections of input signal tags and output signal tags from each pre—defined function block corresponding to functional requirements of the safety related application for the target PLC system;

generate input and output signal tags on the Cause and Effect chart grid;

receive selections in Cause and Effect notation;

generate at least one Cause and Effect control function block corresponding to at least one function requirement of the safety related application for the target PLC system; and

display Cause and Effect notation on the Cause and Effect chart grid at the intersection of input signal tags and output signal tags corresponding to a direct connection of alarm states to shutdown actions for the target PLC system.

45.   (original) A computer according to Claim 40 wherein said computer further configured to:

conform Cause and Effect notation to a specified structure;

validate at least one function block connection and data type; and

verify consistency of defined functional requirements and safety system input/output index.

46.   (original) A computer according to Claim 24 wherein said computer further configured to:

customize a standard function block database to correspond to a target PLC system platform;

re—validate the standard function block database to correspond to the target PLC system platform;

load an executive software package onto the target PLC system

load an application software package onto the target PLC system;

load an executable Cause and Effect chart grid corresponding to function requirements onto the target PLC system; and

utilize the executive software to solve all base Cause and Effect logic gate input requirements.

47.   (currently amended) A database comprising:

data relating to Cause and Effect notation; and

data relating to at least one Function ~~block.~~block applied to control a target PLC system that cannot be controlled by applying the Cause and Effect notation.

48.   (original) A database according to Claim 47 further comprising data relating to Boolean variables.

49.   (original) A database according to Claim 47 further comprising data relating to an HMI (human machine interface) including at least one HMI graphic icon.

50.   (original) A database according to Claim 49 further comprising:

data relating to at least one input signal tag; and

data relating to at least one output signal tag.